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Domain-based Message Authentication, Reporting, and Conformance (DMARC)

Abstract

This document describes the Domain-based Message Authentication, Reporting, and Conformance (DMARC) protocol.

DMARC permits the owner of an email author's domain name to enable validation of the domain's use, to indicate the Domain Owner's or Public Suffix Operator's severity of concern regarding failed validation, and to request reports about use of the domain name. Mail receiving organizations can use this information when evaluating handling choices for incoming mail.

This document obsoletes RFC 7489.

Status of This Memo

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Appendix C. Change Log

C.1. January 5, 2021

C.1.1. Ticket 80 - DMARCbis Should Have Clear and Concise Definition of DMARC

C.2. February 4, 2021

C.2.1. Ticket 1 - SPF RFC 4408 vs 7208

C.3. February 10, 2021

C.3.1. Ticket 84 - Remove Erroneous References to RFC3986

C.4. March 1, 2021

C.4.1. Design Team Work Begins

C.5. March 8, 2021

C.5.1. Removed E. Gustafsson as editor

C.5.2. Ticket 3 - Two tiny nits

C.5.3. Ticket 4 - Definition of "fo" parameter

C.6. March 16, 2021

C.6.1. Ticket 7 - ABNF for dmarc-record is slightly wrong

C.6.2. Ticket 26 - ABNF for pct allows "999"

C.7. March 23, 2021

C.7.1. Ticket 75 - Using wording alternatives to 'disposition', 'dispose', and the like

C.7.2. Ticket 72 - Remove absolute requirement for p= tag in DMARC record

C.8. March 29, 2021

C.8.1. Ticket 54 - Remove or expand limits on number of recipients per report

C.9. April 12, 2021

C.9.1. Ticket 50 - Remove ri= tag

C.9.2. Ticket 66 - Define what it means to have implemented DMARC

C.9.3. Ticket 96 - Tweaks to Abstract and Introduction

C.10. April 13, 2021

C.10.1. Ticket 53 - Remove reporting message size chunking

C.10.2. Ticket 52 - Remove strict alignment (and adkim and aspf tags)

C.10.3. Ticket 47 - Remove pct= tag

C.10.4. Ticket 2 - Flow of operations text in dmarc-base

C.11. April 14, 2021

C.11.1. Ticket 107 - DMARCbis should take a stand on multi-valued From fields

C.11.2. Ticket 82 - Deprecate rf= and maybe fo= tag

C.11.3. Ticket 85 - Proposed change to wording describing 'p' tag and values

C.12. April 15, 2021

C.12.1. Ticket 86 - A-R results for DMARC

C.12.2. Ticket 62 - Make aggregate reporting a normative MUST

C.13. April 19, 2021

C.13.1. Ticket 109 - Sanity Check DMARCbis Document

C.14. April 20, 2021

C.14.1. Ticket 108 - Changes to DMARCbis for PSD

C.15. April 22, 2021

C.15.1. Ticket 104 - Update the Security Considerations section 11.3 on DNS

C.16. June 16, 2021

C.16.1. Publication of draft-ietf-dmarc-dmarcbis-02

Acknowledgements

Authors' Addresses

1. Introduction

RFC EDITOR: PLEASE REMOVE THE FOLLOWING PARAGRAPH BEFORE PUBLISHING:
The source for this draft is maintained in GitHub at: <https://github.com/ietf-wg-dmarc/draft-ietf-dmarc-dmarcbis>

Abusive email often includes unauthorized and deceptive use of a domain name in the RFC5322.From header field. The domain typically belongs to an organization expected to be known to - and presumably trusted by - the recipient. The Sender Policy Framework ([RFC7208]) and DomainKeys Identified Mail ([RFC6376]) protocols provide domain-level authentication but are not directly associated with the RFC5322.From domain. DMARC leverages them, so that Domain Owners publish a DNS record indicating their RFC5322.From field:

- *Email authentication policies

- *Level of concern for mail that fails authentication checks

- *Desire for reports about email use of the domain name

DMARC can cover non-existent sub-domains, below the "Organizational Domain", as well as domains at the top of the name hierarchy, controlled by Public Suffix Operators (PSOs).

As with SPF and DKIM, DMARC classes results as "pass" or "fail". A pass from either SPF or DKIM is required. Depending on the stated DMARC policy, the passed domain must be "aligned" with the RFC5322.From domain in one of two modes - "relaxed" or "strict". Domains are said to be "in relaxed alignment" if they have the same Organizational Domain, which is at the top of the domain hierarchy, while having the same administrative authority as the RFC5322.From domain, while domains are "in strict alignment" if and only if they are identical.

A DMARC pass indicates only that the RFC5322.From domain has been authenticated for that message. Of course, authentication does not carry an explicit or implicit value assertion about that message or about the Domain Owner. Indeed, a mail-receiving organization that performing DMARC validation can choose to follow the Domain Owner's requested disposition for authentication failures, and to inform the Domain Owner of the mail handling decision for that message. It also might choose different actions.

For a mail-receiving organization supporting DMARC, a message that passes validation is part of a message stream that is reliably associated with the RFC5322.From field Domain Owner. Therefore, reputation assessment of that stream by the mail-receiving organization is not encumbered by accounting for unauthorized use of that domain in the RFC5322.From field. A message that fails this validation is not necessarily associated with the Domain Owner's domain and its reputation.

DMARC, in the associated [[DMARC-Aggregate-Reporting](#)] and [[DMARC-Failure-Reporting](#)] documents, also specifies a reporting framework. Using it, a mail-receiving domain can generate regular reports about messages that claim to be from a domain publishing DMARC policies,

sending those reports to the addresses specified by the Domain Owner.

Use of DMARC creates some interoperability challenges that require due consideration before deployment, particularly with configurations that can cause mail to be rejected. These are discussed in [Section 9](#).

2. Requirements

Specification of DMARC is guided by the following high-level goals, security dependencies, detailed requirements, and items that are documented as out of scope.

2.1. High-Level Goals

DMARC has the following high-level goals:

- *Allow Domain Owners and PSOs to assert their severity of concern for authentication failures for messages purporting to have authorship within the domain.
- *Allow Domain Owners and PSOs to verify their authentication deployment.
- *Minimize implementation complexity for both senders and receivers, as well as the impact on handling and delivery of legitimate messages.
- *Reduce the amount of successfully delivered spoofed email.
- *Work at Internet scale.

2.2. Out of Scope

Several topics and issues are specifically out of scope for this work. These include the following:

- *different treatment of messages that are not authenticated versus those that fail authentication;
- *evaluation of anything other than RFC5322.From header field;
- *multiple reporting formats;
- *publishing policy other than via the DNS;
- *reporting or otherwise evaluating other than the last-hop IP address;
- *attacks in the From: header field, also known as "display name" attacks;
- *authentication of entities other than domains, since DMARC is built upon SPF and DKIM, which authenticate domains; and
- *content analysis.

2.3. Scalability

Scalability is a major issue for systems that need to operate in a system as widely deployed as current SMTP email. For this reason, DMARC seeks to avoid the need for third parties or pre-sending agreements between senders and receivers. This preserves the positive aspects of the current email infrastructure.

Although DMARC does not introduce third-party senders (namely external agents authorized to send on behalf of an operator) to the email-handling flow, it also does not preclude them. Such third parties are free to provide services in conjunction with DMARC.

2.4. Anti-Phishing

DMARC is designed to prevent bad actors from sending mail that claims to come from legitimate senders, particularly senders of transactional email (official mail that is about business transactions). One of the primary uses of this kind of spoofed mail is phishing (enticing users to provide information by pretending to be the legitimate service requesting the information). Thus, DMARC is significantly informed by ongoing efforts to enact large-scale, Internet-wide anti-phishing measures.

Although DMARC can only be used to combat specific forms of exact-domain spoofing directly, the DMARC mechanism has been found to be useful in the creation of reliable and defensible message streams.

DMARC does not attempt to solve all problems with spoofed or otherwise fraudulent email. In particular, it does not address the use of visually similar domain names ("cousin domains") or abuse of the RFC5322.From human-readable <display-name>.

3. Terminology and Definitions

This section defines terms used in the rest of the document.

3.1. Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

Readers are encouraged to be familiar with the contents of [[RFC5598](#)]. In particular, that document defines various roles in the messaging infrastructure that can appear the same or separate in various contexts. For example, a Domain Owner could, via the messaging security mechanisms on which DMARC is based, delegate the ability to send mail as the Domain Owner to a third party with another role. This document does not address the distinctions among such roles; the reader is encouraged to become familiar with that material before continuing.

3.2. Authenticated Identifiers

Domain-level identifiers that are validated using authentication technologies are referred to as "Authenticated Identifiers". See [Section 4.1](#) for details about the supported mechanisms.

3.3. Author Domain

The domain name of the apparent author, as extracted from the From: header field.

3.4. Domain Owner

An entity or organization that owns a DNS domain. The term "owns" here indicates that the entity or organization being referenced holds the registration of that DNS domain. Domain Owners range from complex, globally distributed organizations, to service providers working on behalf of non-technical clients, to individuals responsible for maintaining personal domains. This specification uses this term as analogous to an Administrative Management Domain as defined in [[RFC5598](#)]. It can also refer to delegates, such as Report Receivers, when those are outside of their immediate management domain.

3.5. Identifier Alignment

When the domain in the address in the From: header field has the same Organizational Domain as a domain validated by SPF or DKIM (or both), it has Identifier Alignment. (see below)

3.6. Longest PSD

The term Longest PSD is defined in [[DMARC-PSD](#)].

3.7. Mail Receiver

The entity or organization that receives and processes email. Mail Receivers operate one or more Internet- facing Mail Transport Agents (MTAs).

3.8. Non-existent Domains

For DMARC purposes, a non-existent domain is a domain for which there is an NXDOMAIN or NODATA response for A, AAAA, and MX records. This is a broader definition than that in [[RFC8020](#)].

3.9. Organizational Domain

The domain that was registered with a domain name registrar. In the absence of more accurate methods, heuristics are used to determine this, since it is not always the case that the registered domain name is simply a top-level DNS domain plus one component (e.g., "example.com", where "com" is a top-level domain). The Organizational Domain is determined by applying the algorithm found in [Section 3.15](#).

3.10. Public Suffix Domain (PSD)

The term Public Suffix Domain is defined in [[DMARC-PSD](#)].

3.11. Public Suffix Operator (PSO)

The term Public Suffix Operator is defined in [[DMARC-PSD](#)].

3.12. PSO Controlled Domain Names

The term PSO Controlled Domain Names is defined in [[DMARC-PSD](#)].

3.13. Report Receiver

An operator that receives reports from another operator implementing the reporting mechanisms described in this document. Such an operator might be receiving reports about messages related to a domain for which it is the Domain Owner or PSO, or reports about messages related to another operator's domain. This term applies collectively to the system components that receive and process these reports and the organizations that operate them.

3.14. More on Identifier Alignment

Email authentication technologies authenticate various (and disparate) aspects of an individual message. For example, DKIM [[RFC6376](#)] authenticates the domain that affixed a signature to the message, while SPF [[RFC7208](#)] can authenticate either the domain that appears in the RFC5321.MailFrom (MAIL FROM) portion of [[RFC5322](#)] or the RFC5321.EHLO/ HELO domain, or both. These may be different domains, and they are typically not visible to the end user.

DMARC authenticates use of the RFC5322.From domain by requiring that it have the same Organizational Domain (be aligned with) as an Authenticated Identifier. The RFC5322.From domain was selected as the central identity of the DMARC mechanism because it is a required message header field and therefore guaranteed to be present in compliant messages, and most Mail User Agents (MUAs) represent the RFC5322.From header field as the originator of the message and render some or all of this header field's content to end users.

Thus, this field is the one used by end users to identify the source of the message and therefore is a prime target for abuse. Many high-profile email sources, such as email service providers, require that the sending agent have authenticated before email can be generated. Thus, for these mailboxes, the mechanism described in this document provides recipient end users with strong evidence that the message was indeed originated by the agent they associate with that mailbox, if the end user knows that these various protections have been provided.

Domain names in this context are to be compared in a case-insensitive manner, per [[RFC4343](#)].

It is important to note that Identifier Alignment cannot occur with a message that is not valid per [[RFC5322](#)], particularly one with a malformed, absent, or repeated RFC5322.From header field, since in that case there is no reliable way to determine a DMARC policy that

applies to the message. Accordingly, DMARC operation is predicated on the input being a valid RFC5322 message object, and handling of such non-compliant cases is outside of the scope of this specification. Further discussion of this can be found in [Section 6.7.1](#).

Each of the underlying authentication technologies that DMARC takes as input yields authenticated domains as their outputs when they succeed.

3.14.1. DKIM-Authenticated Identifiers

DMARC requires Identifier Alignment based on the result of a DKIM authentication because a message can bear a valid signature from any domain, including domains used by a mailing list or even a bad actor. Therefore, merely bearing a valid signature is not enough to infer authenticity of the Author Domain.

DMARC permits Identifier Alignment based on the result of a DKIM authentication to be strict or relaxed. (Note that these terms are not related to DKIM's "simple" and "relaxed" canonicalization modes.)

In relaxed mode, the Organizational Domains of both the DKIM-authenticated signing domain (taken from the value of the d= tag in the signature) and that of the RFC5322.From domain must be equal if the identifiers are to be considered to be aligned. In strict mode, only an exact match between both the Fully Qualified Domain Names (FQDNs) is considered to produce Identifier Alignment.

To illustrate, in relaxed mode, if a validated DKIM signature successfully verifies with a "d=" domain of "example.com", and the RFC5322.From address is "alerts@news.example.com", the DKIM "d=" domain and the RFC5322.From domain are considered to be "in alignment". In strict mode, this test would fail because the d= domain does not exactly match the RFC5322.From domain.

However, a DKIM signature bearing a value of "d=com" would never allow an "in alignment" result, as "com" should appear on all public suffix lists (see [Appendix A.6.1](#)) and therefore cannot be an Organizational Domain.

Note that a single email can contain multiple DKIM signatures, and it is considered to produce a DMARC "pass" result if any DKIM signature is aligned and verifies.

3.14.2. SPF-Authenticated Identifiers

DMARC permits Identifier Alignment based on the result of an SPF authentication. As with DKIM, Identifier Alignment can be either strict or relaxed.

In relaxed mode, the Organizational Domains of the SPF-authenticated domain and RFC5322.From domain must be equal if the identifiers are to be considered to be aligned. In strict mode, the two FQDNs must match exactly in order for them to be considered to be aligned.

For example, in relaxed mode, if a message passes an SPF check with an RFC5321.MailFrom domain of "cbg.bounces.example.com", and the address portion of the RFC5322.From header field contains "payments@example.com", the Authenticated RFC5321.MailFrom domain identifier and the RFC5322.From domain are considered to be "in alignment" because they have the same Organizational Domain ("example.com"). In strict mode, this test would fail because the two domains are not identical.

The reader should note that SPF alignment checks in DMARC rely solely on the RFC5321.MailFrom domain. This differs from section 2.3 of [[RFC7208](#)], which recommends that SPF checks be done on not only the "MAIL FROM" but also on a separate check of the "HELO" identity.

3.14.3. Alignment and Extension Technologies

If in the future DMARC is extended to include the use of other authentication mechanisms, the extensions will need to allow for domain identifier extraction so that alignment with the RFC5322.From domain can be verified.

3.15. Determining The Organizational Domain

The Organizational Domain is determined using the following algorithm:

1. Acquire a "public suffix" list, i.e., a list of DNS domain names reserved for registrations. Some country Top-Level Domains (TLDs) make specific registration requirements, e.g., the United Kingdom places company registrations under ".co.uk"; other TLDs such as ".com" appear in the IANA registry of top-level DNS domains. A public suffix list is the union of all of these. [Appendix A.6.1](#) contains some discussion about obtaining a public suffix list.
2. Break the subject DNS domain name into a set of "n" ordered labels. Number these labels from right to left; e.g., for "example.com", "com" would be label 1 and "example" would be label 2.
3. Search the public suffix list for the name that matches the largest number of labels found in the subject DNS domain. Let that number be "x".
4. Construct a new DNS domain name using the name that matched from the public suffix list and prefixing to it the "x+1"th label from the subject domain. This new name is the Organizational Domain.

Thus, since "com" is an IANA-registered TLD, a subject domain of "a.b.c.d.example.com" would have an Organizational Domain of "example.com".

The process of determining a suffix is currently a heuristic one. No list is guaranteed to be accurate or current.

Ticket 109, Original text: (Seems like these two paragraphs should be moved elsewhere?)

In addition to Mediators, mail that is sent by authorized, independent third parties might not be sent with Identifier Alignment, also preventing a "pass" result.

Issues specific to the use of policy mechanisms alongside DKIM are further discussed in [[RFC6377](#)], particularly Section 5.2.

4. Overview

This section provides a general overview of the design and operation of the DMARC environment.

4.1. Authentication Mechanisms

The following mechanisms for determining Authenticated Identifiers are supported in this version of DMARC:

- *DKIM, [[RFC6376](#)], which provides a domain-level identifier in the content of the "d=" tag of a validated DKIM-Signature header field.

- *SPF, [[RFC7208](#)], which can authenticate both the domain found in an [[RFC5322](#)] HELO/EHLO command (the HELO identity) and the domain found in an SMTP MAIL command (the MAIL FROM identity). Section 2.4 of [[RFC7208](#)] describes MAIL FROM processing for cases in which the MAIL command has a null path.

4.2. Key Concepts

DMARC policies are published by the Domain Owner or PSO, and retrieved by the Mail Receiver during the SMTP session, via the DNS.

DMARC's filtering function is based on whether the RFC5322.From domain is aligned with (has the same Organizational Domain as) an authenticated domain name from SPF or DKIM. When a DMARC policy is published for the domain name found in the RFC5322.From header field, and that domain name is not validated through SPF or DKIM, the handling of that message can be affected by that DMARC policy when delivered to a participating receiver.

It is important to note that the authentication mechanisms employed by DMARC authenticate only a DNS domain and do not authenticate the local-part of any email address identifier found in a message, nor do they validate the legitimacy of message content.

DMARC's feedback component involves the collection of information about received messages claiming to be from the Author Domain for periodic aggregate reports to the Domain Owner or PSO. The parameters and format for such reports are discussed in [[DMARC-Aggregate-Reporting](#)]

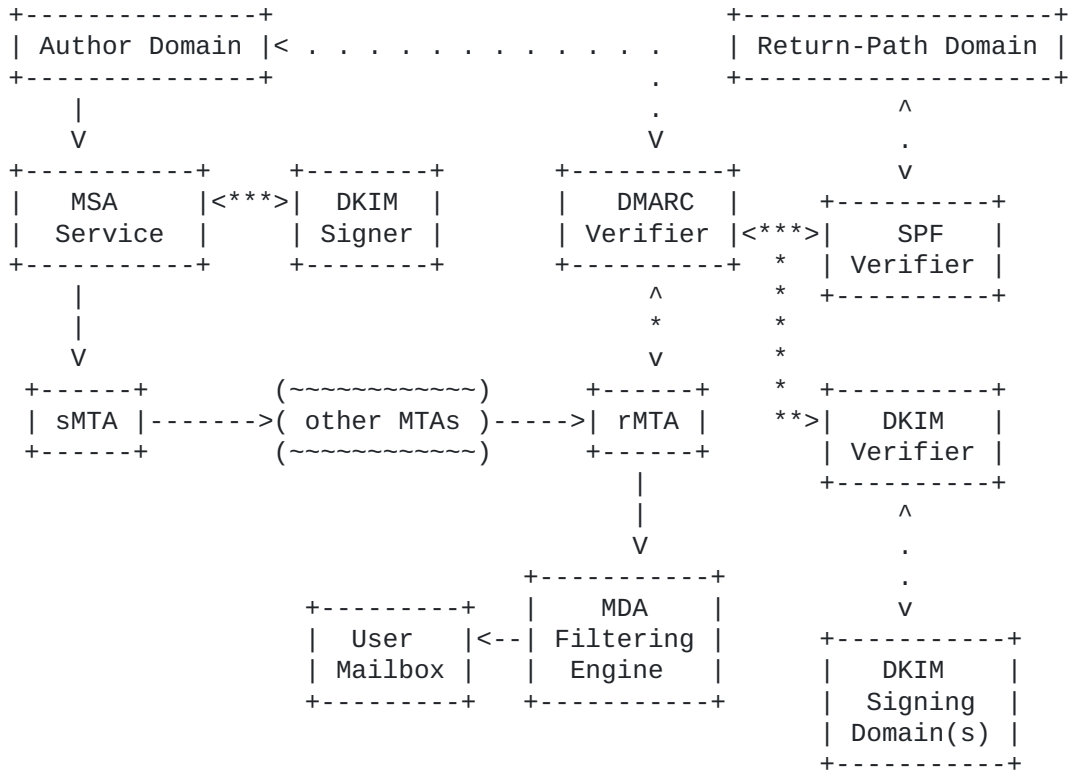
A DMARC-enabled Mail Receiver might also generate per-message reports that contain information related to individual messages that fail SPF and/or DKIM. Per-message failure reports are a useful source of information when debugging deployments (if messages can be determined to be legitimate even though failing authentication) or in analyzing attacks. The capability for such services is enabled by

DMARC but defined in other referenced material such as [RFC6591] and [DMARC-Failure-Reporting]

A message satisfies the DMARC checks if at least one of the supported authentication mechanisms:

1. produces a "pass" result, and
2. produces that result based on an identifier that is in alignment, as defined in Section 3.

4.3. Flow Diagram



MSA = Mail Submission Agent
MDA = Mail Delivery Agent

The above diagram shows a simple flow of messages through a DMARC-aware system. Solid lines denote the actual message flow, dotted lines involve DNS queries used to retrieve message policy related to the supported message authentication schemes, and asterisk lines indicate data exchange between message-handling modules and message authentication modules. "sMTA" is the sending MTA, and "rMTA" is the receiving MTA.

Put simply, when a message reaches a DMARC-aware rMTA, a DNS query will be initiated to determine if the author domain has published a DMARC policy. If a policy is found, the rMTA will use the results of SPF and DKIM validation checks to determine the ultimate DMARC authentication status. The DMARC status can then factor into the message handling decision made by the recipient's mail system.

More details on specific actions for the parties involved can be found in [Section 6.5](#) and [Section 6.7](#).

5. Use of RFC5322.From

One of the most obvious points of security scrutiny for DMARC is the choice to focus on an identifier, namely the RFC5322.From address, which is part of a body of data that has been trivially forged throughout the history of email.

Several points suggest that it is the most correct and safest thing to do in this context:

- *Of all the identifiers that are part of the message itself, this is the only one guaranteed to be present.

- *It seems the best choice of an identifier on which to focus, as most MUAs display some or all of the contents of that field in a manner strongly suggesting those data as reflective of the true originator of the message.

The absence of a single, properly formed RFC5322.From header field renders the message invalid. Handling of such a message is outside of the scope of this specification.

Since the sorts of mail typically protected by DMARC participants tend to only have single Authors, DMARC participants generally operate under a slightly restricted profile of RFC5322 with respect to the expected syntax of this field. See [Section 6.7](#) for details.

6. Policy

DMARC policies are published by Domain Owners and PSOs and can be used by Mail Receivers to inform their message handling decisions.

A Domain Owner or PSO advertises DMARC participation of one or more of its domains by adding a DNS TXT record (described in [Section 6.1](#)) to those domains. In doing so, Domain Owners and PSOs indicate their severity of concern regarding failed authentication for email messages making use of their domain in the RFC5322.From header field as well as the provision of feedback about those messages. Mail Receivers in turn can take into account the Domain Owner's severity of concern when making handling decisions about email messages that fail DMARC authentication checks.

A Domain Owner or PSO may choose not to participate in DMARC evaluation by Mail Receivers. In this case, the Domain Owner simply declines to advertise participation in those schemes. For example, if the results of path authorization checks ought not be considered as part of the overall DMARC result for a given Author Domain, then the Domain Owner does not publish an SPF policy record that can produce an SPF pass result.

A Mail Receiver implementing the DMARC mechanism SHOULD make a best-effort attempt to adhere to the Domain Owner's or PSO's published DMARC Domain Owner Assessment Policy when a message fails the DMARC test.

Since email streams can be complicated (due to forwarding, existing

RFC5322.From domain-spoofing services, etc.), Mail Receivers MAY deviate from a published Domain Owner Assessment Policy during message processing and SHOULD make available the fact of and reason for the deviation to the Domain Owner via feedback reporting, specifically using the "PolicyOverride" feature of the aggregate report defined in [[DMARC-Aggregate-Reporting](#)]

6.1. DMARC Policy Record

Domain Owner and PSO DMARC preferences are stored as DNS TXT records in subdomains named "_dmarc". For example, the Domain Owner of "example.com" would post DMARC preferences in a TXT record at "_dmarc.example.com". Similarly, a Mail Receiver wishing to query for DMARC preferences regarding mail with an RFC5322.From domain of "example.com" would issue a TXT query to the DNS for the subdomain of "_dmarc.example.com". The DNS-located DMARC preference data will hereafter be called the "DMARC record".

DMARC's use of the Domain Name Service is driven by DMARC's use of domain names and the nature of the query it performs. The query requirement matches with the DNS, for obtaining simple parametric information. It uses an established method of storing the information, associated with the target domain name, namely an isolated TXT record that is restricted to the DMARC context. Use of the DNS as the query service has the benefit of reusing an extremely well-established operations, administration, and management infrastructure, rather than creating a new one.

Per [[RFC1035](#)], a TXT record can comprise several "character-string" objects. Where this is the case, the module performing DMARC evaluation MUST concatenate these strings by joining together the objects in order and parsing the result as a single string.

6.2. DMARC URIs

[[RFC3986](#)] defines a generic syntax for identifying a resource. The DMARC mechanism uses this as the format by which a Domain Owner or PSO specifies the destination for the two report types that are supported.

The place such URIs are specified (see [Section 6.3](#)) allows a list of these to be provided. The list of URIs is separated by commas (ASCII 0x2c). A report SHOULD be sent to each listed URI provided in the DMARC record.

A formal definition is provided in [Section 6.4](#).

6.3. General Record Format

DMARC records follow the extensible "tag-value" syntax for DNS-based key records defined in DKIM [[RFC6376](#)].

[Section 10](#) creates a registry for known DMARC tags and registers the initial set defined in this document. Only tags defined in this document or in later extensions, and thus added to that registry, are to be processed; unknown tags MUST be ignored.

The following tags are introduced as the initial valid DMARC tags:

adkim:

(plain-text; OPTIONAL; default is "r".) Indicates whether strict or relaxed DKIM Identifier Alignment mode is required by the Domain Owner. See [Section 3.14.1](#) for details. Valid values are as follows:

r: relaxed mode

s: strict mode

aspf: (plain-text; OPTIONAL; default is "r".) Indicates whether strict or relaxed SPF Identifier Alignment mode is required by the Domain Owner. See [Section 3.14.2](#) for details. Valid values are as follows:

r: relaxed mode

s: strict mode

fo: Failure reporting options (plain-text; OPTIONAL; default is "0") Provides requested options for generation of failure reports. Report generators MAY choose to adhere to the requested options. This tag's content MUST be ignored if a "ruf" tag (below) is not also specified. Failure reporting options are shown below. The value of this tag is either "0", "1", or a colon-separated list of the options represented by alphabetic characters.

0: Generate a DMARC failure report if all underlying authentication mechanisms fail to produce an aligned "pass" result.

1: Generate a DMARC failure report if any underlying authentication mechanism produced something other than an aligned "pass" result.

d: Generate a DKIM failure report if the message had a signature that failed evaluation, regardless of its alignment. DKIM-specific reporting is described in [[RFC6651](#)].

s: Generate an SPF failure report if the message failed SPF evaluation, regardless of its alignment. SPF-specific reporting is described in [[RFC6652](#)].

np: Domain Owner Assessment Policy for non-existent subdomains (plain-text; OPTIONAL). Indicates the severity of concern the Domain Owner or PSO has for mail using non-existent subdomains of the domain queried. It applies only to non-existent subdomains of the domain queried and not to either existing subdomains or the domain itself. Its syntax is identical to that of the "p" tag defined below. If the "np" tag is absent, the policy specified by the "sp" tag (if the "sp" tag is present) or the policy specified by the "p" tag, if the "sp" tag is not present, MUST be applied for non-existent subdomains. Note that "np" will be ignored for DMARC records published on subdomains of Organizational Domains and PSDs due to the effect of the DMARC policy discovery mechanism described in [Section 6.7.3](#).

p:

Domain Owner Assessment Policy (plain-text; RECOMMENDED for policy records). Indicates the severity of concern the Domain Owner or PSO has for mail using its domain but not passing DMARC validation. Policy applies to the domain queried and to subdomains, unless subdomain policy is explicitly described using the "sp" or "np" tags. This tag is mandatory for policy records only, but not for third-party reporting records (see [[DMARC-Aggregate-Reporting](#)] and [[DMARC-Failure-Reporting](#)]) Possible values are as follows:

none: The Domain Owner offers no expression of concern.

quarantine: The Domain Owner considers such mail to be suspicious. It is possible the mail is valid, although the failure creates a significant concern.

reject: The Domain Owner considers all such failures to be a clear indication that the use of the domain name is not valid. See [Section 9.3](#) for some discussion of SMTP rejection methods and their implications.

pct: (plain-text integer between 0 and 100, inclusive; OPTIONAL; default is 100). For the RFC5322.From domain to which the DMARC record applies, the "pct" tag is the percentage of messages producing a DMARC result of "fail" to which the Domain Owner wishes its preferred handling policy be applied. However, this MUST NOT be applied to the DMARC-generated reports, all of which must be sent and received unhindered.

The prospect of "all or nothing" is recognized as preventing many organizations from experimenting with strong authentication-based mechanisms. The intent of the "pct" tag is to give Domain Owners a method to enact a slow rollout of enforcement of the DMARC mechanism, but as is discussed in [Section 6.7.4](#) the tag is at best a rough approximation of such a method.

rua: Addresses to which aggregate feedback is to be sent (comma-separated plain-text list of DMARC URIs; OPTIONAL). [[DMARC-Aggregate-Reporting](#)] discusses considerations that apply when the domain name of a URI differs from that of the domain advertising the policy. See [Section 11.5](#) for additional considerations. Any valid URI can be specified.
A Mail Receiver MUST implement support for a "mailto:" URI, i.e., the ability to send a DMARC report via electronic mail. If not provided, Mail Receivers MUST NOT generate aggregate feedback reports. URIs not supported by Mail Receivers MUST be ignored. The aggregate feedback report format is described in the DMARC reporting documents.

ruf: Addresses to which message-specific failure information is to be reported (comma-separated plain-text list of DMARC URIs; OPTIONAL). If present, the Domain Owner or PSO is requesting Mail Receivers to send detailed failure reports about messages that fail the DMARC evaluation in specific ways (see the "fo" tag above). The format of the message to be generated MUST follow the format specified for the "rf" tag. [[DMARC-Failure-Reporting](#)]

discusses considerations that apply when the domain name of a URI differs from that of the domain advertising the policy. A Mail Receiver MUST implement support for a "mailto:" URI, i.e., the ability to send a DMARC report via electronic mail. If not provided, Mail Receivers MUST NOT generate failure reports. See [Section 11.5](#) for additional considerations.

sp: Domain Owner Assessment Policy for all subdomains (plain-text; OPTIONAL). Indicates the severity of concern the Domain Owner or PSO has for mail using an existing subdomain of the domain queried but not passing DMARC validation. It applies only to subdomains of the domain queried and not to the domain itself. Its syntax is identical to that of the "p" tag defined above. If both the "sp" tag is absent and the "np" tag is either absent or not applicable, the policy specified by the "p" tag MUST be applied for subdomains. Note that "sp" will be ignored for DMARC records published on subdomains of Organizational Domains due to the effect of the DMARC policy discovery mechanism described in [Section 6.7.3](#).

v: Version (plain-text; REQUIRED). Identifies the record retrieved as a DMARC record. It MUST have the value of "DMARC1". The value of this tag MUST match precisely; if it does not or it is absent, the entire retrieved record MUST be ignored. It MUST be the first tag in the list.

A DMARC policy record MUST comply with the formal specification found in [Section 6.4](#) in that the "v" tag MUST be present and MUST appear first. Unknown tags MUST be ignored. Syntax errors in the remainder of the record SHOULD be discarded in favor of default values (if any) or ignored outright.

Note that given the rules of the previous paragraph, addition of a new tag into the registered list of tags does not itself require a new version of DMARC to be generated (with a corresponding change to the "v" tag's value), but a change to any existing tags does require a new version of DMARC.

6.4. Formal Definition

The formal definition of the DMARC format, using [[RFC5234](#)], is as follows:

[FIXTHIS: Reference to [RFC3986] in code block]

```

dmarc-uri      = URI
                  ; "URI" is imported from [RFC3986]; commas (ASCII
                  ; 0x2C) and exclamation points (ASCII 0x21)
                  ; MUST be encoded

dmarc-record   = dmarc-version dmarc-sep *(dmarc-tag dmarc-sep)

dmarc-tag      = dmarc-request /
                  dmarc-srequest /
                  dmarc-adkim /
                  dmarc-aspf /
                  dmarc-auri /
                  dmarc-furi /
                  dmarc-fo /
                  dmarc-rfmt
                  ; components other than dmarc-version and
                  ; dmarc-request may appear in any order

dmarc-version  = "v" *WSP "=" *WSP %x44 %x4d %x41 %x52 %x43 %x31

dmarc-sep      = *WSP %x3b *WSP

dmarc-request  = "p" *WSP "=" *WSP
                  ( "none" / "quarantine" / "reject" )

dmarc-srequest = "sp" *WSP "=" *WSP
                  ( "none" / "quarantine" / "reject" )

dmarc-adkim    = "adkim" *WSP "=" *WSP ( "r" / "s" )

dmarc-aspf     = "aspf" *WSP "=" *WSP ( "r" / "s" )

dmarc-auri     = "rua" *WSP "=" *WSP
                  dmarc-uri *( *WSP "," *WSP dmarc-uri )

dmarc-furi     = "ruf" *WSP "=" *WSP
                  dmarc-uri *( *WSP "," *WSP dmarc-uri )

dmarc-fo       = "fo" *WSP "=" *WSP
                  ( "0" / "1" / ( "d" / "s" / "d:s" / "s:d" ) )

dmarc-rfmt     = "rf" *WSP "=" *WSP Keyword *( *WSP ":" Keyword )
                  ; registered reporting formats only

```

"Keyword" is imported from Section 4.1.2 of [\[RFC5321\]](#).

6.5. Domain Owner Actions

This section describes Domain Owner actions to fully implement the DMARC mechanism.

6.5.1. Publish an SPF Policy for an Aligned Domain

Because DMARC relies on SPF [\[RFC7208\]](#) and DKIM [\[RFC6376\]](#), in order to take full advantage of DMARC, a Domain Owner SHOULD first ensure that SPF and DKIM authentication are properly configured. The easiest first step here is to choose a domain to use as the

RFC5321.From domain (i.e., the Return-Path domain) for its mail, one that aligns with the Author Domain, and then publish an SPF policy in DNS for that domain.

6.5.2. Configure Sending System for DKIM Signing Using an Aligned Domain

While it is possible to secure a DMARC pass verdict based on only SPF or DKIM, it is commonly accepted best practice to ensure that both authentication mechanisms are in place in order to guard against failure of just one of them. The Domain Owner SHOULD choose as a DKIM-Signing domain (i.e., the d= domain in the DKIM-Signature header) that aligns with the Author Domain and configure its system to sign using that domain.

6.5.3. Setup a Mailbox to Receive Aggregate Reports

Proper consumption and analysis of DMARC aggregate reports is the key to any successful DMARC deployment for a Domain Owner. DMARC aggregate reports, which are XML documents and are defined in [[DMARC-Aggregate-Reporting](#)], contain valuable data for the Domain Owner, showing sources of mail using the Author Domain. Depending on how mature the Domain Owner's DMARC rollout is, some of these sources could be legitimate ones that were overlooked during the initial deployment of SPF and/or DKIM.

Because the aggregate reports are XML documents, it is strongly advised that they be machine-parsed, so setting up a mailbox involves more than just the physical creation of the mailbox. Many third-party services exist that will process DMARC aggregate reports, or the Domain Owner can create its own set of tools. No matter which method is chosen, the ability to parse these reports and consume the data contained in them will go a long way to ensuring a successful deployment.

6.5.4. Publish a DMARC Policy for the Author Domain

Once SPF, DKIM, and the aggregate reports mailbox are all in place, it's time to publish a DMARC record. For best results, Domain Owners SHOULD start with "p=none", with the rua tag containing the mailbox created in the previous step.

6.5.5. Collect and Analyze Reports and Adjust Authentication

The reason for starting at "p=none" is to ensure that nothing's been missed in the initial SPF and DKIM deployments. In all but the most trivial setups, it is possible for a Domain Owner to overlook a server here or be unaware of a third party sending agreement there. Starting at "p=none", therefore, takes advantage of DMARC's aggregate reporting function, with the Domain Owner using the reports to audit its own mail streams. Should any overlooked systems be found in the reports, the Domain Owner can adjust the SPF record and/or configure DKIM signing for those systems.

6.5.6. Decide If and When to Update DMARC Policy

Once the Domain Owner is satisfied that it is properly authenticating all of its mail, then it is time to decide if it is

appropriate to change the p= value in its DMARC record to p=quarantine or p=reject. Depending on its cadence for sending mail, it may take many months of consuming DMARC aggregate reports before a Domain Owner reaches the point where it is sure that it is properly authenticating all of its mail, and the decision on which p= value to use will depend on its needs.

6.6. PSO Actions

In addition to the DMARC Domain Owner actions, PSOs that require use of DMARC and participate in PSD DMARC ought to make that information available to Mail Receivers. [\[DMARC-PSD\]](#) is an experimental method for doing so, and the experiment is described in Appendix A of that document.

6.7. Mail Receiver Actions

This section describes receiver actions in the DMARC environment.

6.7.1. Extract Author Domain

The domain in the RFC5322.From header field is extracted as the domain to be evaluated by DMARC. If the domain is encoded with UTF-8, the domain name must be converted to an A-label, as described in Section 2.3 of [\[RFC5890\]](#), for further processing.

In order to be processed by DMARC, a message typically needs to contain exactly one RFC5322.From domain (a single From: field with a single domain in it). Not all messages meet this requirement, and the handling of those that are forbidden under RFC 5322 [\[RFC5322\]](#) or that contain no meaningful domains is outside the scope of this document.

The case of a syntactically valid multi-valued RFC5322.From header field presents a particular challenge. When a single RFC5322.From header field contains multiple addresses, it is possible that there may be multiple domains used in those addresses. The process in this case is to only proceed with DMARC checking if the domain is identical for all of the addresses in a multi-valued RFC5322.From header field. Multi-valued RFC5322.From header fields with multiple domains MUST be exempt from DMARC checking.

Note that domain names that appear on a public suffix list are not exempt from DMARC policy application and reporting.

6.7.2. Determine Handling Policy

To arrive at a policy for an individual message, Mail Receivers MUST perform the following actions or their semantic equivalents. Steps 2-4 MAY be done in parallel, whereas steps 5 and 6 require input from previous steps.

The steps are as follows:

1. Extract the RFC5322.From domain from the message (as above).

2. Query the DNS for a DMARC policy record. Continue if one is found, or terminate DMARC evaluation otherwise. See [Section 6.7.3](#) for details.
3. Perform DKIM signature verification checks. A single email could contain multiple DKIM signatures. The results of this step are passed to the remainder of the algorithm, MUST include "pass" or "fail", and if "fail", SHOULD include information about the reasons for failure. The results MUST further include the value of the "d=" and "s=" tags from each checked DKIM signature.
4. Perform SPF validation checks. The results of this step are passed to the remainder of the algorithm, MUST include "pass" or "fail", and if "fail", SHOULD include information about the reasons for failure. The results MUST further include the domain name used to complete the SPF check.
5. Conduct Identifier Alignment checks. With authentication checks and policy discovery performed, the Mail Receiver checks to see if Authenticated Identifiers fall into alignment as described in [Section 3](#). If one or more of the Authenticated Identifiers align with the RFC5322.From domain, the message is considered to pass the DMARC mechanism check. All other conditions (authentication failures, identifier mismatches) are considered to be DMARC mechanism check failures.
6. Apply policy. Emails that fail the DMARC mechanism check are handled in accordance with the discovered DMARC policy of the Domain Owner and any local policy rules enforced by the Mail Receiver. See [Section 6.3](#) for details.

Heuristics applied in the absence of use by a Domain Owner of either SPF or DKIM (e.g., [[Best-Guess-SPF](#)]) SHOULD NOT be used, as it may be the case that the Domain Owner wishes a Message Receiver not to consider the results of that underlying authentication protocol at all.

DMARC evaluation can only yield a "pass" result after one of the underlying authentication mechanisms passes for an aligned identifier. If neither passes and one or both of them fail due to a temporary error, the Receiver evaluating the message is unable to conclude that the DMARC mechanism had a permanent failure; they therefore cannot apply the advertised DMARC policy. When otherwise appropriate, Receivers MAY send feedback reports regarding temporary errors.

Handling of messages for which SPF and/or DKIM evaluation encounter a permanent DNS error is left to the discretion of the Mail Receiver.

6.7.3. Policy Discovery

As stated above, the DMARC mechanism uses DNS TXT records to advertise policy. Policy discovery is accomplished via a method similar to the method used for SPF records. This method, and the important differences between DMARC and SPF mechanisms, are discussed below.

To balance the conflicting requirements of supporting wildcarding, allowing subdomain policy overrides, and limiting DNS query load, the following DNS lookup scheme is employed:

1. Mail Receivers MUST query the DNS for a DMARC TXT record at the DNS domain matching the one found in the RFC5322.From domain in the message. A possibly empty set of records is returned.
2. Records that do not start with a "v=" tag that identifies the current version of DMARC are discarded.
3. If the set is now empty, the Mail Receiver MUST query the DNS for a DMARC TXT record at the DNS domain matching the Organizational Domain in place of the RFC5322.From domain in the message (if different). This record can contain policy to be asserted for subdomains of the Organizational Domain. A possibly empty set of records is returned.
4. If the set is now empty and the longest PSD [Section 3.6](#) of the Organizational Domain is one that the receiver has determined is acceptable for PSD DMARC (discussed in the [\[DMARC-PSD\]](#) experiment description (Appendix A)), the Mail Receiver MUST query the DNS for a DMARC TXT record at the DNS domain matching the [\[DMARC-PSD\]](#) longest PSD [Section 3.6](#) in place of the RFC5322.From domain in the message (if different). A possibly empty set of records is returned.
5. Records that do not start with a "v=" tag that identifies the current version of DMARC are discarded.
6. If the remaining set contains multiple records or no records, policy discovery terminates and DMARC processing is not applied to this message.
7. If a retrieved policy record does not contain a valid "p" tag, or contains an "sp" tag that is not valid, then:
 1. if a "rua" tag is present and contains at least one syntactically valid reporting URI, the Mail Receiver SHOULD act as if a record containing a valid "v" tag and "p=none" was retrieved, and continue processing;
 2. otherwise, the Mail Receiver applies no DMARC processing to this message.

If the set produced by the mechanism above contains no DMARC policy record (i.e., any indication that there is no such record as opposed to a transient DNS error), Mail Receivers SHOULD NOT apply the DMARC mechanism to the message.

Handling of DNS errors when querying for the DMARC policy record is left to the discretion of the Mail Receiver. For example, to ensure minimal disruption of mail flow, transient errors could result in delivery of the message ("fail open"), or they could result in the message being temporarily rejected (i.e., an SMTP 4yx reply), which invites the sending MTA to try again after the condition has possibly cleared, allowing a definite DMARC conclusion to be reached ("fail closed").

6.7.3.1. Longest PSD Example

As an example of step 4 above, for a message with the Organizational Domain of "example.compute.cloudcompany.com.example", the query for PSD DMARC would use "compute.cloudcompany.com.example" as the [DMARC-PSD] longest PSD [Section 3.6](#). The receiver would check to see if that PSD is listed in the DMARC PSD Registry, and if so, perform the policy lookup at "_dmarc.compute.cloudcompany.com.example".

Note: Because the PSD policy query comes after the Organizational Domain policy query, PSD policy is not used for Organizational domains that have published a DMARC policy. Specifically, this is not a mechanism to provide feedback addresses (RUA/RUF) when an Organizational Domain has declined to do so.

6.7.4. Message Sampling

The "pct" tag is intended as a method for Domain Owners to use in a slow rollout of enforcement of the DMARC mechanism. It is designed to allow the Domain Owner to request that only some mail using its domain as the RFC5322.From domain and producing DMARC "fail" results be subject to its strictest requested policy. This section will discuss the idea behind its implementation and the shortcomings inherent in its usage.

6.7.4.1. Intended Implementation of the "pct" Tag

The intended implementation of the "pct" tag by a mail-receiving organization can be stated as follows:

If the "pct" tag is present in the policy record, the Mail Receiver MUST NOT enact the requested policy ("p" tag or "sp" tag") on more than a close approximation of the stated percent of the totality of affected messages.

Such a close approximation might be achieved by use of the following or similar pseudocode:

```
if (random mod 100) < pct then
    selected = true
else
    selected = false
```

With this pseudocode or other methods in place for determining whether or not the message is part of the percentage of messages subject to the express DMARC policy, the following rules apply:

*If email is subject to the DMARC policy of "quarantine", the Mail Receiver SHOULD quarantine the message. If the email is not subject to the "quarantine" policy (due to the "pct" tag), the Mail Receiver SHOULD apply local message classification as normal.

*If email is subject to the DMARC policy of "reject", the Mail Receiver SHOULD reject the message (see [Section 9.3](#)). If the email is not subject to the "reject" policy (due to the "pct" tag), the Mail Receiver SHOULD treat the email as though the "quarantine" policy applies.

However, regardless of whether or not the "pct" tag is present, the Mail Receiver MUST include all relevant message data in any reports produced.

The described behavior here is meant to allow Domain Owners to experiment with progressively stronger policies without relaxing existing policy. However, the use of the phrase "close approximation of the stated percent" along with the pseudocode sample hint at the shortcomings inherent in implementing this tag.

6.7.4.2. Shortcomings of the "pct" Tag

Put simply, the "pct" tag will only work exactly as intended if its value is either "0" or "100". For any other value, the produced results will vary, sometimes greatly, from the intended value, and the size of the variance is likely to be different from day to day.

The "pct" tag is a request to take a sample of a larger population and apply different rules to it. The population is made up of all messages that produce DMARC "fail" results for that domain in a given day, and the sample size is the percentage of that population represented by the value of the "pct" tag. It is trivial to perform this sampling to the exact number specified if the population size is known, but the nature of email is such that the population size cannot be known until all messages have been collected and evaluated that day. Email traffic tends to flow in spurts, not at a constant level throughout the day, and so a volume seen during any time slice cannot be extrapolated across a 24 hour period. Waiting until the end of the day to decide which messages to either quarantine or reject goes against all best practices and exposes the mail-receiving organization to vectors of abuse, and so we must approximate the population and sample sizes on the fly.

The pseudocode shown above is an example of that approximation, relying on a random number generator to effectively produce a whole number between 0 and 99, inclusive. If that number is less than the value of the "pct" tag, then a message producing a DMARC "fail" result will be subject to the DMARC policy in question; if not, it will be subject to the lesser policy. Over time and given enough iterations of the pseudocode, this should produce a roughly uniform distribution of all values across the range, which we will refer to going forward as "the pool". However, mathematics teaches us that the pool cannot be guaranteed to produce the desired result.

The sampling done to honor the "pct" tag is known in mathematics as a Binomial Distribution, where a number of independent samples of the pool are taken, with each one having the same probability of producing a number that is less than the value of the "pct" tag. A Binomial Distribution is expressed by the following function, known as a probability mass function (PMF):

$$f(x) = \frac{n!}{(n-x)! * x!} * p^x * (1 - p)^{n-x}$$

In English, the PMF is a way to calculate the probability that x items from a sample of n items will have the desired result when p is the probability that any one item will have the desired result.

For example, for a DMARC policy record with pct=20, we let $p = 0.2$, and to calculate the probability that 1 out of every 5 messages will be assigned the requested policy, we have:

$$\frac{5!}{(5-1)! * 1!} * 0.2^1 * (1 - 0.2)^{5-1} =$$

$$\frac{120}{24} * 0.2 * 0.8^4 = 5 * 0.2 * 0.4096 = 0.4096$$

$$0.4096 * 100 = 40.96\%$$

The above demonstrates that for every five messages producing a DMARC "fail" result, there is a slightly less than 41% chance that just one of the five will have the requested policy applied to it. The table below shows the percent probability for all possible results:

X	Percent chance that X of 5 will have policy applied
0	32.768%
1	40.96%
2	20.48%
3	5.12%
4	0.64%
5	< 0.1%

It should be clear here that application of the pct tag is quite likely to not be done at the desired level. The only exceptions to this are the following values:

- *"100" - The default, in which every message that produces a DMARC "fail" result will be subject to application of the specified policy.
- *"0" - A request that zero percent of messages producing a DMARC "fail" result have the specified policy applied. While this is seemingly a non-sensical request, this value has been given special meaning by some mailbox providers when combined with certain "p=" values to alter DMARC processing and/or reporting for the domain publishing such a policy.

6.7.5. Store Results of DMARC Processing

The results of Mail Receiver-based DMARC processing should be stored for eventual presentation back to the Domain Owner in the form of

aggregate feedback reports. [Section 6.3](#) and [[DMARC-Aggregate-Reporting](#)] discuss aggregate feedback.

6.7.6. Send Aggregate Reports

For a Domain Owner, DMARC aggregate reports provide data about all mailstreams making use of its domain in email, to include not only illegitimate uses but also, and perhaps more importantly, all legitimate uses. Domain Owners can use aggregate reports to ensure that all legitimate uses of their domain for sending email are properly authenticated, and once they are, increase the severity of concern expressed in the p= tag in their DMARC policy records from none to quarantine to reject, if appropriate. In turn, DMARC policy records with p= tag values of 'quarantine' or 'reject' are higher value signals to Mail Receivers, ones that can assist Mail Receivers with handling decisions for a message in ways that p= tag values of 'none' cannot.

In order to ensure maximum usefulness for DMARC across the email ecosystem, then, Mail Receivers MUST generate and send aggregate reports with a frequency of at least once every 24 hours.

6.8. Policy Enforcement Considerations

Mail Receivers MAY choose to reject or quarantine email even if email passes the DMARC mechanism check. The DMARC mechanism does not inform Mail Receivers whether an email stream is "good". Mail Receivers are encouraged to maintain anti-abuse technologies to combat the possibility of DMARC-enabled criminal campaigns.

Mail Receivers MAY choose to accept email that fails the DMARC mechanism check even if the published Domain Owner Assessment Policy is "reject". Mail Receivers need to make a best effort not to increase the likelihood of accepting abusive mail if they choose not to honor the published Domain Owner Assessment Policy. At a minimum, addition of the Authentication-Results header field (see [[RFC8601](#)]) is RECOMMENDED when delivery of failing mail is done. When this is done, the DNS domain name thus recorded MUST be encoded as an A-label.

Mail Receivers are only obligated to report reject or quarantine policy actions in aggregate feedback reports that are due to published DMARC Domain Owner Assessment Policy. They are not required to report reject or quarantine actions that are the result of local policy. If local policy information is exposed, abusers can gain insight into the effectiveness and delivery rates of spam campaigns.

Final handling of a message is always a matter of local policy. An operator that wishes to favor DMARC policy over SPF policy, for example, will disregard the SPF policy, since enacting an SPF-determined rejection prevents evaluation of DKIM; DKIM might otherwise pass, satisfying the DMARC evaluation. There is a trade-off to doing so, namely acceptance and processing of the entire message body in exchange for the enhanced protection DMARC provides.

DMARC-compliant Mail Receivers typically disregard any mail-handling directive discovered as part of an authentication mechanism (e.g.,

Author Domain Signing Practices (ADSP), SPF) where a DMARC record is also discovered that specifies a policy other than "none". Deviating from this practice introduces inconsistency among DMARC operators in terms of handling of the message. However, such deviation is not proscribed.

To enable Domain Owners to receive DMARC feedback without impacting existing mail processing, discovered policies of "p=none" SHOULD NOT modify existing mail handling processes.

Mail Receivers MUST also implement reporting instructions of DMARC, even in the absence of a request for DKIM reporting [[RFC6651](#)] or SPF reporting [[RFC6652](#)]. Furthermore, the presence of such requests SHOULD NOT affect DMARC reporting.

7. DMARC Feedback

Providing Domain Owners with visibility into how Mail Receivers implement and enforce the DMARC mechanism in the form of feedback is critical to establishing and maintaining accurate authentication deployments. When Domain Owners can see what effect their policies and practices are having, they are better willing and able to use quarantine and reject policies.

The details of this feedback are described in [[DMARC-Aggregate-Reporting](#)]

Operational note for PSD DMARC: For PSDs, feedback for non-existent domains is desirable and useful, just as it is for org-level DMARC operators. See Section 4 of [[DMARC-PSD](#)] for discussion of Privacy Considerations for PSD DMARC

8. Minimum Implementations

Domain owners, mediators, and mail receivers can all claim to implement DMARC, but what that means will depend on their role in the transmission of mail. To remove any ambiguity from the claims, this document specifies the following minimum criteria that must be met for each agent to rightly claim to be "implementing DMARC".

Domain Owner: To implement DMARC, a Domain Owner MUST configure its domain to convey its concern that unauthenticated mail be rejected or at least treated with suspicion. This means that it MUST publish a policy record that:

- *Has a p tag with a value of 'quarantine' or 'reject'

- *Has a rua tag with at least one valid URI

- *If applicable, has an sp tag with a value of 'quarantine' or 'reject'

While 'none' is a syntactically valid value for both the p and sp tags, the practical value of either the p tag or sp tag being 'none' means that the Domain Owner is still gathering information about mail flows for the domain or sub-domains. It is not yet ready to commit to conveying a severity of concern for unauthenticated email using its domain.

Mediator: To implement DMARC, a mediator MUST do the following before passing the message to the next hop or rejecting it as appropriate:

- *Perform DMARC validation checks on inbound mail
- *Perform validation on any authentication checks recorded by previous mediators.
- *Record the results of its authentication checks in message headers for consumption by later hosts.

Mail Receiver: To implement DMARC, a mail receiver MUST do the following:

- *Perform DMARC validation checks on inbound mail
- *Perform validation checks on any authentication check results recorded by mediators that handled the message prior to its reaching the Mail Receiver.
- *Send aggregate reports to Domain Owners at least every 24 hours when a minimum of 100 messages with that domain in the RFC5322.From header field have been seen during the reporting period

9. Other Topics

This section discusses some topics regarding choices made in the development of DMARC, largely to commit the history to record.

9.1. Issues Specific to SPF

Though DMARC does not inherently change the semantics of an SPF policy record, historically lax enforcement of such policies has led many to publish extremely broad records containing many large network ranges. Domain Owners are strongly encouraged to carefully review their SPF records to understand which networks are authorized to send on behalf of the Domain Owner before publishing a DMARC record.

Some receiver architectures might implement SPF in advance of any DMARC operations. This means that a "-" prefix on a sender's SPF mechanism, such as "-all", could cause that rejection to go into effect early in handling, causing message rejection before any DMARC processing takes place. Operators choosing to use "-all" should be aware of this.

9.2. DNS Load and Caching

DMARC policies are communicated using the DNS and therefore inherit a number of considerations related to DNS caching. The inherent conflict between freshness and the impact of caching on the reduction of DNS-lookup overhead should be considered from the Mail Receiver's point of view. Should Domain Owners or PSOs publish a DNS record with a very short TTL, Mail Receivers can be provoked through the injection of large volumes of messages to overwhelm the publisher's DNS. Although this is not a concern specific to DMARC,

the implications of a very short TTL should be considered when publishing DMARC policies.

Conversely, long TTLs will cause records to be cached for long periods of time. This can cause a critical change to DMARC parameters advertised by a Domain Owner or PSO to go unnoticed for the length of the TTL (while waiting for DNS caches to expire). Avoiding this problem can mean shorter TTLs, with the potential problems described above. A balance should be sought to maintain responsiveness of DMARC preference changes while preserving the benefits of DNS caching.

9.3. Rejecting Messages

This proposal calls for rejection of a message during the SMTP session under certain circumstances. This is preferable to generation of a Delivery Status Notification ([\[RFC3464\]](#)), since fraudulent messages caught and rejected using DMARC would then result in annoying generation of such failure reports that go back to the RFC5321.MailFrom address.

This synchronous rejection is typically done in one of two ways:

- *Full rejection, wherein the SMTP server issues a 5xy reply code as an indication to the SMTP client that the transaction failed; the SMTP client is then responsible for generating notification that delivery failed (see Section 4.2.5 of [\[RFC5321\]](#)).

- *A "silent discard", wherein the SMTP server returns a 2xy reply code implying to the client that delivery (or, at least, relay) was successfully completed, but then simply discarding the message with no further action.

Each of these has a cost. For instance, a silent discard can help to prevent backscatter, but it also effectively means that the SMTP server has to be programmed to give a false result, which can confound external debugging efforts.

Similarly, the text portion of the SMTP reply may be important to consider. For example, when rejecting a message, revealing the reason for the rejection might give an attacker enough information to bypass those efforts on a later attempt, though it might also assist a legitimate client to determine the source of some local issue that caused the rejection.

In the latter case, when doing an SMTP rejection, providing a clear hint can be useful in resolving issues. A receiver might indicate in plain text the reason for the rejection by using the word "DMARC" somewhere in the reply text. Many systems are able to scan the SMTP reply text to determine the nature of the rejection. Thus, providing a machine-detectable reason for rejection allows the problems causing rejections to be properly addressed by automated systems. For example:

550 5.7.1 Email rejected per DMARC policy for example.com

If a Mail Receiver elects to defer delivery due to inability to retrieve or apply DMARC policy, this is best done with a 4xy SMTP reply code.

9.4. Identifier Alignment Considerations

The DMARC mechanism allows both DKIM and SPF-authenticated identifiers to authenticate email on behalf of a Domain Owner and, possibly, on behalf of different subdomains. If malicious or unaware users can gain control of the SPF record or DKIM selector records for a subdomain, the subdomain can be used to generate DMARC-passing email on behalf of the Organizational Domain.

For example, an attacker who controls the SPF record for "evil.example.com" can send mail with an RFC5322.From header field containing "foo@example.com" that can pass both authentication and the DMARC check against "example.com".

The Organizational Domain administrator should be careful not to delegate control of subdomains if this is an issue, and to consider using the "strict" Identifier Alignment option if appropriate.

9.5. Interoperability Issues

DMARC limits which end-to-end scenarios can achieve a "pass" result.

Because DMARC relies on [\[RFC7208\]](#) and/or [\[RFC6376\]](#) to achieve a "pass", their limitations also apply.

Additional DMARC constraints occur when a message is processed by some Mediators, such as mailing lists. Transiting a Mediator often causes either the authentication to fail or Identifier Alignment to be lost. These transformations may conform to standards but will still prevent a DMARC "pass".

In addition to Mediators, mail that is sent by authorized, independent third parties might not be sent with Identifier Alignment, also preventing a "pass" result.

Issues specific to the use of policy mechanisms alongside DKIM are further discussed in [\[RFC6377\]](#), particularly Section 5.2.

10. IANA Considerations

This section describes actions completed by IANA.

10.1. Authentication-Results Method Registry Update

IANA has added the following to the "Email Authentication Methods" registry:

Method: dmarc

Defined: RFC 7489

pType: header

Property: from

Value: the domain portion of the RFC5322.From header field

Status: active

Version: 1

Method: dmarc

Defined: RFC 7489

ptype: polrec

Property: p

Value: the p= value read from the discovered policy record

Status: active

Version: 1

Method: dmarc

Defined: RFC 7489

ptype: polrec

Property: domain

Value: the domain at which the policy record was discovered, if different from the RFC5322.From domain

Status: active

Version: 1

10.2. Authentication-Results Result Registry Update

IANA has added the following in the "Email Authentication Result Names" registry:

Code: none

Existing/New Code: existing

Defined: [[RFC8601](#)]

Auth Method: dmarc (added)

Meaning: No DMARC policy record was published for the aligned identifier, or no aligned identifier could be extracted.

Status: active

Code: pass

Existing/New Code: existing

Defined: [[RFC8601](#)]

Auth Method: dmarc (added)

Meaning: A DMARC policy record was published for the aligned identifier, and at least one of the authentication mechanisms passed.

Status: active

Code: fail

Existing/New Code: existing

Defined: [[RFC8601](#)]

Auth Method: dmarc (added)

Meaning: A DMARC policy record was published for the aligned identifier, and none of the authentication mechanisms passed.

Status: active

Code: temperror

Existing/New Code: existing

Defined: [[RFC8601](#)]

Auth Method: dmarc (added)

Meaning: A temporary error occurred during DMARC evaluation. A later attempt might produce a final result.

Status: active

Code: permerror

Existing/New Code: existing

Defined: [[RFC8601](#)]

Auth Method: dmarc (added)

Meaning: A permanent error occurred during DMARC evaluation, such as encountering a syntactically incorrect DMARC record. A later attempt is unlikely to produce a final result.

Status: active

10.3. Feedback Report Header Fields Registry Update

The following has been added to the "Feedback Report Header Fields" registry:

Field Name: Identity-Alignment

Description: indicates whether the message about which a report is being generated had any identifiers in alignment as defined in RFC 7489

Multiple Appearances: No

Related "Feedback-Type": auth-failure

Reference: RFC 7489

Status: current

10.4. DMARC Tag Registry

A new registry tree called "Domain-based Message Authentication, Reporting, and Conformance (DMARC) Parameters" has been created. Within it, a new sub-registry called the "DMARC Tag Registry" has been created.

Names of DMARC tags must be registered with IANA in this new sub-registry. New entries are assigned only for values that have been documented in a manner that satisfies the terms of Specification Required, per [[RFC8126](#)]. Each registration must include the tag name; the specification that defines it; a brief description; and its status, which must be one of "current", "experimental", or "historic". The Designated Expert needs to confirm that the provided specification adequately describes the new tag and clearly presents how it would be used within the DMARC context by Domain Owners and Mail Receivers.

To avoid version compatibility issues, tags added to the DMARC specification are to avoid changing the semantics of existing records when processed by implementations conforming to prior specifications.

The initial set of entries in this registry is as follows:

Tag Name	Reference	Status	Description
adkim	RFC 7489	current	DKIM alignment mode
aspf	RFC 7489	current	SPF alignment mode
fo	RFC 7489	current	Failure reporting options
p	RFC 7489	current	Requested handling policy
pct	RFC 7489	current	Sampling rate
rf	RFC 7489	historic	Failure reporting format(s)
ri	RFC 7489	historic	Aggregate Reporting interval
rua	RFC 7489	current	Reporting URI(s) for aggregate data
ruf	RFC 7489	current	Reporting URI(s) for failure data
sp	RFC 7489	current	Requested handling policy for subdomains
v	RFC 7489	current	Specification version

Table 1: "DMARC Tag Registry"

10.5. DMARC Report Format Registry

Also within "Domain-based Message Authentication, Reporting, and Conformance (DMARC) Parameters", a new sub-registry called "DMARC Report Format Registry" has been created.

Names of DMARC failure reporting formats must be registered with IANA in this registry. New entries are assigned only for values that satisfy the definition of Specification Required, per [RFC8126]. In addition to a reference to a permanent specification, each registration must include the format name; a brief description; and its status, which must be one of "current", "experimental", or "historic". The Designated Expert needs to confirm that the provided specification adequately describes the report format and clearly presents how it would be used within the DMARC context by Domain Owners and Mail Receivers.

The initial entry in this registry is as follows:

Format Name	Reference	Status	Description
afrf	RFC 7489	current	Authentication Failure Reporting Format (see [RFC6591])

Table 2: "DMARC Report Format Registry"

10.6. Underscored and Globally Scoped DNS Node Names Registry

Per [!@RFC8552], please add the following entry to the "Underscored and Globally Scoped DNS Node Names" registry:

RR Type	_NODE NAME	Reference
TXT	_dmarc	RFC 7489

Table 3: "Underscored and Globally Scoped DNS Node Names" registry

11. Security Considerations

This section discusses security issues and possible remediations (where available) for DMARC.

11.1. Authentication Methods

Security considerations from the authentication methods used by DMARC are incorporated here by reference.

11.2. Attacks on Reporting URIs

URIs published in DNS TXT records are well-understood possible targets for attack. Specifications such as [RFC1035] and [RFC2142] either expose or cause the exposure of email addresses that could be flooded by an attacker, for example; MX, NS, and other records found in the DNS advertise potential attack destinations; common DNS names such as "www" plainly identify the locations at which particular services can be found, providing destinations for targeted denial-of-service or penetration attacks.

Thus, Domain Owners will need to harden these addresses against various attacks, including but not limited to:

- *high-volume denial-of-service attacks;
- *deliberate construction of malformed reports intended to identify or exploit parsing or processing vulnerabilities;
- *deliberate construction of reports containing false claims for the Submitter or Reported-Domain fields, including the possibility of false data from compromised but known Mail Receivers.

11.3. DNS Security

The DMARC mechanism and its underlying technologies (SPF, DKIM) depend on the security of the DNS. If hostile parties can snoop on DNS traffic, they can get an idea of who is sending mail. If they can block outgoing or reply DNS messages, they can prevent systems from discovering senders' DMARC policies, causing recipients to assume `p=none` by default/ If they can send forged response packets, they can make aligned mail appear unaligned or vice-versa.

None of these threats are unique to DMARC, and they can be addressed using a variety of techniques. Signing DNS records with DNSSEC [[RFC4033](#)] enables recipients to detect and discard forged responses. DNS over TLS [[RFC7858](#)] or DNS over HTTPS [[RFC8484](#)] can mitigate snooping and forged responses.

11.4. Display Name Attacks

A common attack in messaging abuse is the presentation of false information in the display-name portion of the RFC5322.From header field. For example, it is possible for the email address in that field to be an arbitrary address or domain name, while containing a well-known name (a person, brand, role, etc.) in the display name, intending to fool the end user into believing that the name is used legitimately. The attack is predicated on the notion that most common MUAs will show the display name and not the email address when both are available.

Generally, display name attacks are out of scope for DMARC, as further exploration of possible defenses against these attacks needs to be undertaken.

There are a few possible mechanisms that attempt mitigation of these attacks, such as the following:

- *If the display name is found to include an email address (as specified in [[RFC5322](#)]), execute the DMARC mechanism on the domain name found there rather than the domain name discovered originally. However, this addresses only a very specific attack space, and spoofer can easily circumvent it by simply not using an email address in the display name. There are also known cases of legitimate uses of an email address in the display name with a domain different from the one in the address portion, e.g.,

From: "user@example.org via Bug Tracker" support@example.com

*In the MUA, only show the display name if the DMARC mechanism succeeds. This too is easily defeated, as an attacker could arrange to pass the DMARC tests while fraudulently using another domain name in the display name.

*In the MUA, only show the display name if the DMARC mechanism passes and the email address thus validated matches one found in the receiving user's list of known addresses.

11.5. External Reporting Addresses

To avoid abuse by bad actors, reporting addresses generally have to be inside the domains about which reports are requested. In order to accommodate special cases such as a need to get reports about domains that cannot actually receive mail, The DMARC reporting documents describe a DNS-based mechanism for verifying approved external reporting.

The obvious consideration here is an increased DNS load against domains that are claimed as external recipients. Negative caching will mitigate this problem, but only to a limited extent, mostly dependent on the default TTL in the domain's SOA record.

Where possible, external reporting is best achieved by having the report be directed to domains that can receive mail and simply having it automatically forwarded to the desired external destination.

Note that the addresses shown in the "ruf" tag receive more information that might be considered private data, since it is possible for actual email content to appear in the failure reports. The URIs identified there are thus more attractive targets for intrusion attempts than those found in the "rua" tag. Moreover, attacking the DNS of the subject domain to cause failure data to be routed fraudulently to an attacker's systems may be an attractive prospect. Deployment of [[RFC4033](#)] is advisable if this is a concern.

The verification mechanism presented in the DMARC reporting documents is currently not mandatory ("MUST") but strongly recommended ("SHOULD"). It is possible that it would be elevated to a "MUST" by later security review.

11.6. Secure Protocols

This document encourages use of secure transport mechanisms to prevent loss of private data to third parties that may be able to monitor such transmissions. Unencrypted mechanisms should be avoided.

In particular, a message that was originally encrypted or otherwise secured might appear in a report that is not sent securely, which could reveal private information.

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Appendix A. Technology Considerations

This section documents some design decisions that were made in the development of DMARC. Specifically, addressed here are some suggestions that were considered but not included in the design. This text is included to explain why they were considered and not included in this version.

A.1. S/MIME

S/MIME, or Secure Multipurpose Internet Mail Extensions, is a standard for encryption and signing of MIME data in a message. This was suggested and considered as a third security protocol for authenticating the source of a message.

DMARC is focused on authentication at the domain level (i.e., the Domain Owner taking responsibility for the message), while S/MIME is really intended for user-to-user authentication and encryption. This alone appears to make it a bad fit for DMARC's goals.

S/MIME also suffers from the heavyweight problem of Public Key Infrastructure, which means that distribution of keys used to verify signatures needs to be incorporated. In many instances, this alone is a showstopper. There have been consistent promises that PKI usability and deployment will improve, but these have yet to materialize. DMARC can revisit this choice after those barriers are addressed.

S/MIME has extensive deployment in specific market segments (government, for example) but does not enjoy similar widespread deployment over the general Internet, and this shows no signs of changing. DKIM and SPF both are deployed widely over the general Internet, and their adoption rates continue to be positive.

Finally, experiments have shown that including S/MIME support in the initial version of DMARC would neither cause nor enable a substantial increase in the accuracy of the overall mechanism.

A.2. Method Exclusion

It was suggested that DMARC include a mechanism by which a Domain Owner could tell Message Receivers not to attempt validation by one of the supported methods (e.g., "check DKIM, but not SPF").

Specifically, consider a Domain Owner that has deployed one of the technologies, and that technology fails for some messages, but such failures don't cause enforcement action. Deploying DMARC would cause enforcement action for policies other than "none", which would appear to exclude participation by that Domain Owner.

The DMARC development team evaluated the idea of policy exception mechanisms on several occasions and invariably concluded that there was not a strong enough use case to include them. The specific target audience for DMARC does not appear to have concerns about the failure modes of one or the other being a barrier to DMARC's adoption.

In the scenario described above, the Domain Owner has a few options:

1. Tighten up its infrastructure to minimize the failure modes of the single deployed technology.
2. Deploy the other supported authentication mechanism, to offset the failure modes of the first.
3. Deploy DMARC in a reporting-only mode.

A.3. Sender Header Field

It has been suggested in several message authentication efforts that the Sender header field be checked for an identifier of interest, as the standards indicate this as the proper way to indicate a re-mailing of content such as through a mailing list. Most recently, it was a protocol-level option for DomainKeys, but on evolution to DKIM, this property was removed.

The DMARC development team considered this and decided not to include support for doing so, for the following reasons:

1. The main user protection approach is to be concerned with what the user sees when a message is rendered. There is no consistent behavior among MUAs regarding what to do with the content of the Sender field, if present. Accordingly, supporting checking of the Sender identifier would mean applying policy to an identifier the end user might never actually see, which can create a vector for attack against end users by simply forging a Sender field containing some identifier that DMARC will like.
2. Although it is certainly true that this is what the Sender field is for, its use in this way is also unreliable, making it a poor candidate for inclusion in the DMARC evaluation algorithm.

3. Allowing multiple ways to discover policy introduces unacceptable ambiguity into the DMARC evaluation algorithm in terms of which policy is to be applied and when.

A.4. Domain Existence Test

A common practice among MTA operators, and indeed one documented in [[RFC5617](#)], is a test to determine domain existence prior to any more expensive processing. This is typically done by querying the DNS for MX, A, or AAAA resource records for the name being evaluated and assuming that the domain is nonexistent if it could be determined that no such records were published for that domain name.

The original pre-standardization version of this protocol included a mandatory check of this nature. It was ultimately removed, as the method's error rate was too high without substantial manual tuning and heuristic work. There are indeed use cases this work needs to address where such a method would return a negative result about a domain for which reporting is desired, such as a registered domain name that never sends legitimate mail and thus has none of these records present in the DNS.

A.5. Issues with ADSP in Operation

DMARC has been characterized as a "super-ADSP" of sorts.

Contributors to DMARC have compiled a list of issues associated with ADSP, gained from operational experience, that have influenced the direction of DMARC:

1. ADSP has no support for subdomains, i.e., the ADSP record for example.com does not explicitly or implicitly apply to subdomain.example.com. If wildcarding is not applied, then spammers can trivially bypass ADSP by sending from a subdomain with no ADSP record.
2. Nonexistent subdomains are explicitly out of scope in ADSP. There is nothing in ADSP that states receivers should simply reject mail from NXDOMAINs regardless of ADSP policy (which of course allows spammers to trivially bypass ADSP by sending email from nonexistent subdomains).
3. ADSP has no operational advice on when to look up the ADSP record.
4. ADSP has no support for using SPF as an auxiliary mechanism to DKIM.
5. ADSP has no support for a slow rollout, i.e., no way to configure a percentage of email on which the receiver should apply the policy. This is important for large-volume senders.
6. ADSP has no explicit support for an intermediate phase where the receiver quarantines (e.g., sends to the recipient's "spam" folder) rather than rejects the email.
7. The binding between the "From" header domain and DKIM is too tight for ADSP; they must match exactly.

A.6. Organizational Domain Discovery Issues

Although protocols like ADSP are useful for "protecting" a specific domain name, they are not helpful at protecting subdomains. If one wished to protect "example.com" by requiring via ADSP that all mail bearing an RFC5322.From domain of "example.com" be signed, this would "protect" that domain; however, one could then craft an email whose RFC5322.From domain is "security.example.com", and ADSP would not provide any protection. One could use a DNS wildcard, but this can undesirably interfere with other DNS activity; one could add ADSP records as fraudulent domains are discovered, but this solution does not scale and is a purely reactive measure against abuse.

The DNS does not provide a method by which the "domain of record", or the domain that was actually registered with a domain registrar, can be determined given an arbitrary domain name. Suggestions have been made that attempt to glean such information from SOA or NS resource records, but these too are not fully reliable, as the partitioning of the DNS is not always done at administrative boundaries.

When seeking domain-specific policy based on an arbitrary domain name, one could "climb the tree", dropping labels off the left end of the name until the root is reached or a policy is discovered, but then one could craft a name that has a large number of nonsense labels; this would cause a Mail Receiver to attempt a large number of queries in search of a policy record. Sending many such messages constitutes an amplified denial-of-service attack.

The Organizational Domain mechanism is a necessary component to the goals of DMARC. The method described in [Section 3.15](#) is far from perfect but serves this purpose reasonably well without adding undue burden or semantics to the DNS. If a method is created to do so that is more reliable and secure than the use of a public suffix list, DMARC should be amended to use that method as soon as it is generally available.

A.6.1. Public Suffix Lists

A public suffix list for the purposes of determining the Organizational Domain can be obtained from various sources. The most common one is maintained by the Mozilla Foundation and made public at <http://publicsuffix.org>. License terms governing the use of that list are available at that URI.

Note that if operators use a variety of public suffix lists, interoperability will be difficult or impossible to guarantee.

Appendix B. Examples

This section illustrates both the Domain Owner side and the Mail Receiver side of a DMARC exchange.

B.1. Identifier Alignment Examples

The following examples illustrate the DMARC mechanism's use of Identifier Alignment. For brevity's sake, only message headers are

shown, as message bodies are not considered when conducting DMARC checks.

B.1.1. SPF

The following SPF examples assume that SPF produces a passing result.

Example 1: SPF in alignment:

```
MAIL FROM: <sender@example.com>

From: sender@example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the RFC5321.MailFrom parameter and the RFC5322.From header field have identical DNS domains. Thus, the identifiers are in strict alignment.

Example 2: SPF in alignment (parent):

```
MAIL FROM: <sender@child.example.com>

From: sender@example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the RFC5322.From header parameter includes a DNS domain that is a parent of the RFC5321.MailFrom domain. Thus, the identifiers are in relaxed alignment.

Example 3: SPF not in alignment:

```
MAIL FROM: <sender@example.net>

From: sender@child.example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the RFC5321.MailFrom parameter includes a DNS domain that is neither the same as, a parent of, nor a child of the RFC5322.From domain. Thus, the identifiers are not in alignment.

B.1.2. DKIM

The examples below assume that the DKIM signatures pass verification. Alignment cannot exist with a DKIM signature that does not verify.

Example 1: DKIM in alignment:

```
DKIM-Signature: v=1; ...; d=example.com; ...
From: sender@example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the DKIM "d=" parameter and the RFC5322.From header field have identical DNS domains. Thus, the identifiers are in strict alignment.

Example 2: DKIM in alignment (parent):

```
DKIM-Signature: v=1; ...; d=example.com; ...
From: sender@child.example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the DKIM signature's "d=" parameter includes a DNS domain that is a parent of the RFC5322.From domain. Thus, the identifiers are in relaxed alignment.

Example 3: DKIM not in alignment:

```
DKIM-Signature: v=1; ...; d=sample.net; ...
From: sender@child.example.com
Date: Fri, Feb 15 2002 16:54:30 -0800
To: receiver@example.org
Subject: here's a sample
```

In this case, the DKIM signature's "d=" parameter includes a DNS domain that is neither the same as, a parent of, nor a child of the RFC5322.From domain. Thus, the identifiers are not in alignment.

B.2. Domain Owner Example

A Domain Owner that wants to use DMARC should have already deployed and tested SPF and DKIM. The next step is to publish a DNS record that advertises a DMARC policy for the Domain Owner's Organizational Domain.

B.2.1. Entire Domain, Monitoring Only

The owner of the domain "example.com" has deployed SPF and DKIM on its messaging infrastructure. The owner wishes to begin using DMARC with a policy that will solicit aggregate feedback from receivers without affecting how the messages are processed, in order to:

- *Confirm that its legitimate messages are authenticating correctly
- *Verify that all authorized message sources have implemented authentication measures
- *Determine how many messages from other sources would be affected by a blocking policy

The Domain Owner accomplishes this by constructing a policy record indicating that:

- *The version of DMARC being used is "DMARC1" ("v=DMARC1;")
- *Receivers should not alter how they treat these messages because of this DMARC policy record ("p=none")
- *Aggregate feedback reports should be sent via email to the address "dmarc-feedback@example.com" ("rua=mailto:dmarc-feedback@example.com")
- *All messages from this Organizational Domain are subject to this policy (no "pct" tag present, so the default of 100% applies).

The DMARC policy record might look like this when retrieved using a common command-line tool:

```
% dig +short TXT _dmarc.example.com.  
"v=DMARC1; p=none; rua=mailto:dmarc-feedback@example.com"
```

To publish such a record, the DNS administrator for the Domain Owner creates an entry like the following in the appropriate zone file (following the conventional zone file format):

```
; DMARC record for the domain example.com  
  
_dmarc IN TXT ( "v=DMARC1; p=none; "  
                "rua=mailto:dmarc-feedback@example.com" )
```

B.2.2. Entire Domain, Monitoring Only, Per-Message Reports

The Domain Owner from the previous example has used the aggregate reporting to discover some messaging systems that had not yet implemented DKIM correctly, but they are still seeing periodic authentication failures. In order to diagnose these intermittent problems, they wish to request per-message failure reports when authentication failures occur.

Not all Receivers will honor such a request, but the Domain Owner feels that any reports it does receive will be helpful enough to justify publishing this record. The default per-message report format ([RFC6591](#)) meets the Domain Owner's needs in this scenario.

The Domain Owner accomplishes this by adding the following to its policy record from [Appendix B.2](#):

- *Per-message failure reports should be sent via email to the address "auth-reports@example.com" ("ruf=mailto:auth-reports@example.com")

The DMARC policy record might look like this when retrieved using a common command-line tool (the output shown would appear on a single line but is wrapped here for publication):

```
% dig +short TXT _dmarc.example.com.  
"v=DMARC1; p=none; rua=mailto:dmarc-feedback@example.com;  
ruf=mailto:auth-reports@example.com"
```

To publish such a record, the DNS administrator for the Domain Owner might create an entry like the following in the appropriate zone file (following the conventional zone file format):

```
; DMARC record for the domain example.com

_dmarc IN TXT ( "v=DMARC1; p=none; "
                "rua=mailto:dmARC-feedback@example.com; "
                "ruf=mailto:auth-reports@example.com" )
```

B.2.3. Per-Message Failure Reports Directed to Third Party

The Domain Owner from the previous example is maintaining the same policy but now wishes to have a third party receive and process the per-message failure reports. Again, not all Receivers will honor this request, but those that do may implement additional checks to validate that the third party wishes to receive the failure reports for this domain.

The Domain Owner needs to alter its policy record from [Appendix B.2.2](#) as follows:

```
*Per-message failure reports should be sent via email to the
  address "auth-reports@thirdparty.example.net" ("ruf=mailto:auth-
  reports@thirdparty.example.net")
```

The DMARC policy record might look like this when retrieved using a common command-line tool (the output shown would appear on a single line but is wrapped here for publication):

```
% dig +short TXT _dmarc.example.com.
"v=DMARC1; p=none; rua=mailto:dmARC-feedback@example.com;
ruf=mailto:auth-reports@thirdparty.example.net"
```

To publish such a record, the DNS administrator for the Domain Owner might create an entry like the following in the appropriate zone file (following the conventional zone file format):

```
; DMARC record for the domain example.com

_dmarc IN TXT ( "v=DMARC1; p=none; "
                "rua=mailto:dmARC-feedback@example.com; "
                "ruf=mailto:auth-reports@thirdparty.example.net" )
```

Because the address used in the "ruf" tag is outside the Organizational Domain in which this record is published, conforming Receivers will implement additional checks as described in the DMARC reporting documents. In order to pass these additional checks, the third party will need to publish an additional DNS record as follows:

```
*Given the DMARC record published by the Domain Owner at
  "_dmarc.example.com", the DNS administrator for the third party
  will need to publish a TXT resource record at
  "example.com._report._dmarc.thirdparty.example.net" with the
  value "v=DMARC1;".
```

The resulting DNS record might look like this when retrieved using a common command-line tool (the output shown would appear on a single line but is wrapped here for publication):

```
% dig +short TXT example.com._report._dmarc.thirdparty.example.net
"v=DMARC1;"
```

To publish such a record, the DNS administrator for example.net might create an entry like the following in the appropriate zone file (following the conventional zone file format):

```
; zone file for thirdparty.example.net
; Accept DMARC failure reports on behalf of example.com

example.com._report._dmarc  IN  TXT  "v=DMARC1;"
```

Mediators and other third parties should refer to the DMARC reporting documents for the full details of this mechanism.

B.2.4. Subdomain, Sampling, and Multiple Aggregate Report URIs

The Domain Owner has implemented SPF and DKIM in a subdomain used for pre-production testing of messaging services. It now wishes to express a severity of concern for messages from this subdomain that fail to authenticate to indicate to participating receivers that use of this domain is not valid.

As a first step, it will express that it considers to be suspicious messages using this subdomain that fail authentication. The goal here will be to enable examination of messages sent to mailboxes hosted by participating receivers as method for troubleshooting any existing authentication issues. Aggregate feedback reports will be sent to a mailbox within the Organizational Domain, and to a mailbox at a third party selected and authorized to receive same by the Domain Owner.

The Domain Owner will accomplish this by constructing a policy record indicating that:

- *The version of DMARC being used is "DMARC1" ("v=DMARC1;")
- *It is applied only to this subdomain (record is published at "_dmarc.test.example.com" and not "_dmarc.example.com")
- *Receivers are advised that the Domain Owner considers messages that fail to authenticate to be suspicious ("p=quarantine")
- *Aggregate feedback reports should be sent via email to the addresses "dmarc-feedback@example.com" and "example-tld-test@thirdparty.example.net" ("rua=mailto:dmarc-feedback@example.com, mailto:tld-test@thirdparty.example.net")
- *The Domain Owner desires that only 25% of messages using this Organizational Domain that fail authentication are subject to this policy ("pct=25")

The DMARC policy record might look like this when retrieved using a common command-line tool (the output shown would appear on a single line but is wrapped here for publication):

```
% dig +short TXT _dmarc.test.example.com
"v=DMARC1; p=quarantine; rua=mailto:dmarc-feedback@example.com,
mailto:tld-test@thirdparty.example.net pct=25"
```

To publish such a record, the DNS administrator for the Domain Owner might create an entry like the following in the appropriate zone file:

```
; DMARC record for the domain test.example.com

_dmarc IN TXT ( "v=DMARC1; p=quarantine; "
                "rua=mailto:dmarc-feedback@example.com,"
                "mailto:tld-test@thirdparty.example.net;"
                "pct=25" )
```

Once enough time has passed to allow for collecting enough reports to give the Domain Owner confidence that all legitimate email sent using the subdomain is properly authenticating and passing DMARC checks, then the Domain Owner can update the policy record to indicate that it considers authentication failures to be a clear indication that use of the subdomain is not valid. It would do this by altering the DNS record to advise receivers of its position on such messages ("p=reject").

After alteration, the DMARC policy record might look like this when retrieved using a common command-line tool (the output shown would appear on a single line but is wrapped here for publication):

```
% dig +short TXT _dmarc.test.example.com
"v=DMARC1; p=reject; rua=mailto:dmarc-feedback@example.com,
mailto:tld-test@thirdparty.example.net"
```

To publish such a record, the DNS administrator for the Domain Owner might create an entry like the following in the appropriate zone file:

```
; DMARC record for the domain test.example.com

_dmarc IN TXT ( "v=DMARC1; p=reject; "
                "rua=mailto:dmarc-feedback@example.com,"
                "mailto:tld-test@thirdparty.example.net" )
```

B.3. Mail Receiver Example

A Mail Receiver that wants to use DMARC should already be checking SPF and DKIM, and possess the ability to collect relevant information from various email-processing stages to provide feedback to Domain Owners (possibly via Report Receivers).

B.4. Processing of SMTP Time

An optimal DMARC-enabled Mail Receiver performs authentication and Identifier Alignment checking during the [[RFC5321](#)] conversation.

Prior to returning a final reply to the DATA command, the Mail Receiver's MTA has performed:

1. An SPF check to determine an SPF-authenticated Identifier.
2. DKIM checks that yield one or more DKIM-authenticated Identifiers.
3. A DMARC policy lookup.

The presence of an Author Domain DMARC record indicates that the Mail Receiver should continue with DMARC-specific processing before returning a reply to the DATA command.

Given a DMARC record and the set of Authenticated Identifiers, the Mail Receiver checks to see if the Authenticated Identifiers align with the Author Domain (taking into consideration any strict versus relaxed options found in the DMARC record).

For example, the following sample data is considered to be from a piece of email originating from the Domain Owner of "example.com":

```
Author Domain: example.com
SPF-authenticated Identifier: mail.example.com
DKIM-authenticated Identifier: example.com
DMARC record:
  "v=DMARC1; p=reject; aspf=r;
  rua=mailto:dmarc-feedback@example.com"
```

In the above sample, both the SPF-authenticated Identifier and the DKIM-authenticated Identifier align with the Author Domain. The Mail Receiver considers the above email to pass the DMARC check, avoiding the "reject" policy that is requested to be applied to email that fails to pass the DMARC check.

If no Authenticated Identifiers align with the Author Domain, then the Mail Receiver applies the DMARC-record-specified policy. However, before this action is taken, the Mail Receiver can consult external information to override the Domain Owner's Assessment Policy.

For example, if the Mail Receiver knows that this particular email came from a known and trusted forwarder (that happens to break both SPF and DKIM), then the Mail Receiver may choose to ignore the Domain Owner's policy.

The Mail Receiver is now ready to reply to the DATA command. If the DMARC check yields that the message is to be rejected, then the Mail Receiver replies with a 5xy code to inform the sender of failure. If the DMARC check cannot be resolved due to transient network errors, then the Mail Receiver replies with a 4xy code to inform the sender as to the need to reattempt delivery later. If the DMARC check yields a passing message, then the Mail Receiver continues on with email processing, perhaps using the result of the DMARC check as an input to additional processing modules such as a domain reputation query.

Before exiting DMARC-specific processing, the Mail Receiver checks to see if the Author Domain DMARC record requests AFRF-based

reporting. If so, then the Mail Receiver can emit an AFRF to the reporting address supplied in the DMARC record.

At the exit of DMARC-specific processing, the Mail Receiver captures (through logging or direct insertion into a data store) the result of DMARC processing. Captured information is used to build feedback for Domain Owner consumption. This is not necessary if the Domain Owner has not requested aggregate reports, i.e., no "rua" tag was found in the policy record.

B.5. Utilization of Aggregate Feedback: Example

Aggregate feedback is consumed by Domain Owners to verify a Domain Owner's understanding of how the Domain Owner's domain is being processed by the Mail Receiver. Aggregate reporting data on emails that pass all DMARC-supporting authentication checks is used by Domain Owners to verify that authentication practices remain accurate. For example, if a third party is sending on behalf of a Domain Owner, the Domain Owner can use aggregate report data to verify ongoing authentication practices of the third party.

Data on email that only partially passes underlying authentication checks provides visibility into problems that need to be addressed by the Domain Owner. For example, if either SPF or DKIM fails to pass, the Domain Owner is provided with enough information to either directly correct the problem or understand where authentication-breaking changes are being introduced in the email transmission path. If authentication-breaking changes due to email transmission path cannot be directly corrected, then the Domain Owner at least maintains an understanding of the effect of DMARC-based policies upon the Domain Owner's email.

Data on email that fails all underlying authentication checks provides baseline visibility on how the Domain Owner's domain is being received at the Mail Receiver. Based on this visibility, the Domain Owner can begin deployment of authentication technologies across uncovered email sources. Additionally, the Domain Owner may come to an understanding of how its domain is being misused.

(Aggregate report example should be moved to [[DMARC-Aggregate-Reporting](#)])

Appendix C. Change Log

C.1. January 5, 2021

C.1.1. Ticket 80 - DMARCbis SHould Have Clear and Concise Defintion of DMARC

*Updated text for Abstract and Introduction sections.

*Diffs are recorded here - <https://github.com/ietf-wg-dmarc/draft-ietf-dmarc-dmarcbis/pull/1/files>

C.2. February 4, 2021

C.2.1. Ticket 1 - SPF RFC 4408 vs 7208

*Some rearranging of text in the "SPF-Authenticated Identifiers" section

*Clarification of the term "in alignment" in that same section

*Diffs are here - <https://github.com/ietf-wg-dmarc/draft-ietf-dmarc-dmarcbis/pull/3/files>

C.3. February 10, 2021

C.3.1. Ticket 84 - Remove Erroneous References to RFC3986

*Several references to RFC3986 changed to RFC7208

*Diffs are here - <https://github.com/ietf-wg-dmarc/draft-ietf-dmarc-dmarcbis/pull/4/files>

C.4. March 1, 2021

C.4.1. Design Team Work Begins

*Added change log section to document

C.5. March 8, 2021

C.5.1. Removed E. Gustafsson as editor

*He withdrew as editor after a job change.

C.5.2. Ticket 3 - Two tiny nits

*Changes to wording in section 6.6.2, Determine Handling Policy, steps 3 and 4.

*New text documented here - <https://trac.ietf.org/trac/dmarc/ticket/3#comment:6>

*No change to section 6.6.3, Policy Discovery; ticket seems to pre-date current text, which appears to have answered the concern raised.

C.5.3. Ticket 4 - Definition of "fo" parameter

*Changes to wording in section 6.3, to bring clarity to use of colon-separated list as possible value to "fo"

*New text documented here - <https://trac.ietf.org/trac/dmarc/ticket/4#comment:4>

C.6. March 16, 2021

C.6.1. Ticket 7 - ABNF for dmarc-record is slightly wrong

*New text documented here - <https://trac.ietf.org/trac/dmarc/ticket/7>

C.6.2. Ticket 26 - ABNF for pct allows "999"

*Updated ABNF for dmarc-percent

*New text documented here - <https://trac.ietf.org/trac/dmarc/ticket/26#comment:6>

*Ticket 47, Remove pct= tag, rendered change obsolete

C.7. March 23, 2021

C.7.1. Ticket 75 - Using wording alternatives to 'disposition', 'dispose', and the like

*Changed disposition/dispose to "handling"

*Diffs documented here - <https://trac.ietf.org/trac/dmarc/ticket/75#comment:3>

C.7.2. Ticket 72 - Remove absolute requirement for p= tag in DMARC record

*Changed from REQUIRED to RECOMMENDED, noted default with forward reference to discussion

*Diffs documented here - <https://trac.ietf.org/trac/dmarc/ticket/72#comment:3>

C.8. March 29, 2021

C.8.1. Ticket 54 - Remove or expand limits on number of recipients per report

*Removed limit

*Diffs documented here - <https://trac.ietf.org/trac/dmarc/ticket/54#comment:5>

C.9. April 12, 2021

C.9.1. Ticket 50 - Remove ri= tag

*Updated text to recommend against its usage, a la the ptr mechanism in RFC 7208

*Diffs documented here - <https://trac.ietf.org/trac/dmarc/ticket/50#comment:5>

C.9.2. Ticket 66 - Define what it means to have implemented DMARC

*Proposed new text (taken straight from <https://trac.ietf.org/trac/dmarc/ticket/66> as replacement for current text in "Minimum Implementations"

C.9.3. Ticket 96 - Tweaks to Abstract and Introduction

*Changed phrase in Abstract to "an email author's domain name"

*Changed phrase in Introduction to "reports about email use of the domain name"

C.10. April 13, 2021

C.10.1. Ticket 53 - Remove reporting message size chunking

*Proposed text to remove all references to message size chunking

*Data demonstrating lack of use of feature entered into ticket - <https://trac.ietf.org/trac/dmarc/ticket/53#comment:4>

C.10.2. Ticket 52 - Remove strict alignment (and adkim and aspf tags)

*Proposed text to remove all references to strict alignment

*Data demonstrating lack of use of feature entered into ticket - <https://trac.ietf.org/trac/dmarc/ticket/52#comment:2>

C.10.3. Ticket 47 - Remove pct= tag

*Proposed text to remove all references to pct and message sampling

*Data demonstrating lack of use of feature entered into ticket - <https://trac.ietf.org/trac/dmarc/ticket/47#comment:4>

C.10.4. Ticket 2 - Flow of operations text in dmarc-base

*Update ASCII Art

*Proposed text to replace description of ASCII Art

*Proposed text to update Domain Owner Actions section

C.11. April 14, 2021

C.11.1. Ticket 107 - DMARCbis should take a stand on multi-valued From fields

*Proposed text that limits processing to only those times when all domains are the same.

C.11.2. Ticket 82 - Deprecate rf= and maybe fo= tag

*Proposed text to deprecate rf= tag, while leaving fo= tag as is

C.11.3. Ticket 85 - Proposed change to wording describing 'p' tag and values

*The language expressing the semantics is proposed to be changed to be, in a sense, egocentric. How do I, the domain owner feel about (assess) the meaning of a DMARC failure?

C.12. April 15, 2021

C.12.1. Ticket 86 - A-R results for DMARC

*Proposed text to add for polrec.p and polrec.domain methods for registry update.

*Did not include polrec.pct due to proposal to remove pct tag (Ticket 47)

C.12.2. Ticket 62 - Make aggregate reporting a normative MUST

*Proposed text to do just that in Mail Receiver Actions, section titled "Send Aggregate Reports"

C.13. April 19, 2021

C.13.1. Ticket 109 - Sanity Check DMARCBis Document

*Updated document to remove all "original text"/"proposed text" couplets in favor of one (hopefully coherent) document full of proposed text changes.

*Noted which tickets were the cause of whatever rfcdiff output will show in tracker

C.14. April 20, 2021

C.14.1. Ticket 108 - Changes to DMARCBis for PSD

*Incorporating requests for changes to DMARCBis made in text of "Experimental DMARC Extension for Public Suffix Domains" (<https://datatracker.ietf.org/doc/draft-ietf-dmarc-psd/>)

C.15. April 22, 2021

C.15.1. Ticket 104 - Update the Security Considerations section 11.3 on DNS

*Updated text. Diffs are here - <https://github.com/ietf-wg-dmarc/draft-ietf-dmarc-dmarcbis/pull/31/files>

C.16. June 16, 2021

C.16.1. Publication of draft-ietf-dmarc-dmarcbis-02

*Includes final resolution for tickets 4, 47, 50, 52, 53, 54, and 82

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